
Space Weather Technical Forecast

Issued on Tuesday, 22 August 2023 at 01:31 Local

This technical forecast provides a four day assessment of space weather events. The probabilities stated below are for reaching or exceeding the given levels. For more information about space weather impacts please see the Met Office Space Weather Scales <https://www.metoffice.gov.uk/weather/learn-about/space-weather/uk-scales>

Space Weather Forecast Headline: Chance of M-class flares (R1-R2; Minor-Moderate radio blackouts). Current coronal hole high speed stream (HSS) influence waning.

Analysis of Space Weather Activity over past 24 hours

Solar Activity: Solar activity is Low, with the peak flare reaching C5.7 at 21/2359 UTC from a region currently at the eastern horizon in the southern hemisphere. There are currently eight sunspot regions on the Earth-facing side of the Sun. AR3413 near the northeast limb has now revealed further small spots in addition to the large, leading H-spot and is classified as a Cho/Beta group. There continues to be occasional low-mid level C-class flaring from this region. AR3407 (Cso/Beta) in the southwest has seen gradual decaying of the lead spots. AR3404 (Cro/Beta) in the southwest faded then re-emerged, though has shown signs of decaying again in recent hours. Otherwise there was little change to the other pre-existing regions on the disc which remain generally simple and stable.

A region just over the eastern limb presents some bright flux on EUV imagery in the southern hemisphere around 20S and is likely to contain another sunspot group. Despite being far-sided it has been responsible for numerous flares from low to mid-C class level in the past 48 hours and could be a notable region.

A filament eruption was observed leaving the sun around 21/1600 UTC from a region just to the northeast of AR3404, however, no CME has been detected in either LASCO or STEREO imagery. Therefore no Earth-directed CMEs have been identified during the period.

Solar Wind / Geomagnetic Activity: The solar wind as measured by DSCOVR and ACE at L1 has been Elevated to Strong throughout, generally between 570-650km/s at first with a peak of 680 km/s noted at 21/0935 UTC. This enhancement was due to an unnumbered, trans-equatorial, negative polarity coronal hole currently located around 60W. During the second half of the UTC day on 21 August, the solar wind weakened to fall to persistently Elevated levels (between 510-550km/s) by the end of the period as the HSS began to ease. The density of particles carried by the solar wind was below average levels throughout, with a peak of 4ppcc recorded at 21/0623 UTC. The phi angle was accordingly almost exclusively negative (towards the Sun). The magnetic field, IMF (Bt) was Weak and on a declining trend with a peak value of 7nT recorded at 21/0106 UTC. The north-south component, Bz, ranged weakly between +6 and -5nT, with no particular bias overall. The net result of the above solar wind measures was for Quiet to Unsettled geomagnetic activity (Kp1-3).

Energetic Particles / Solar Radiation: GOES16 high energy (greater than 10MeV) proton flux remained at Background levels. GOES16 high energy (greater than 2MeV) electron flux ranged from Normal Background to Moderate levels, varying on a typical diurnal trend. The associated 24-hour fluence was well below the Active level, with an observed value of 1.26e6 integrated pfu at 22/0001UTC, on a slow, then rising upward trend.

Four-Day Space Weather Forecast Summary

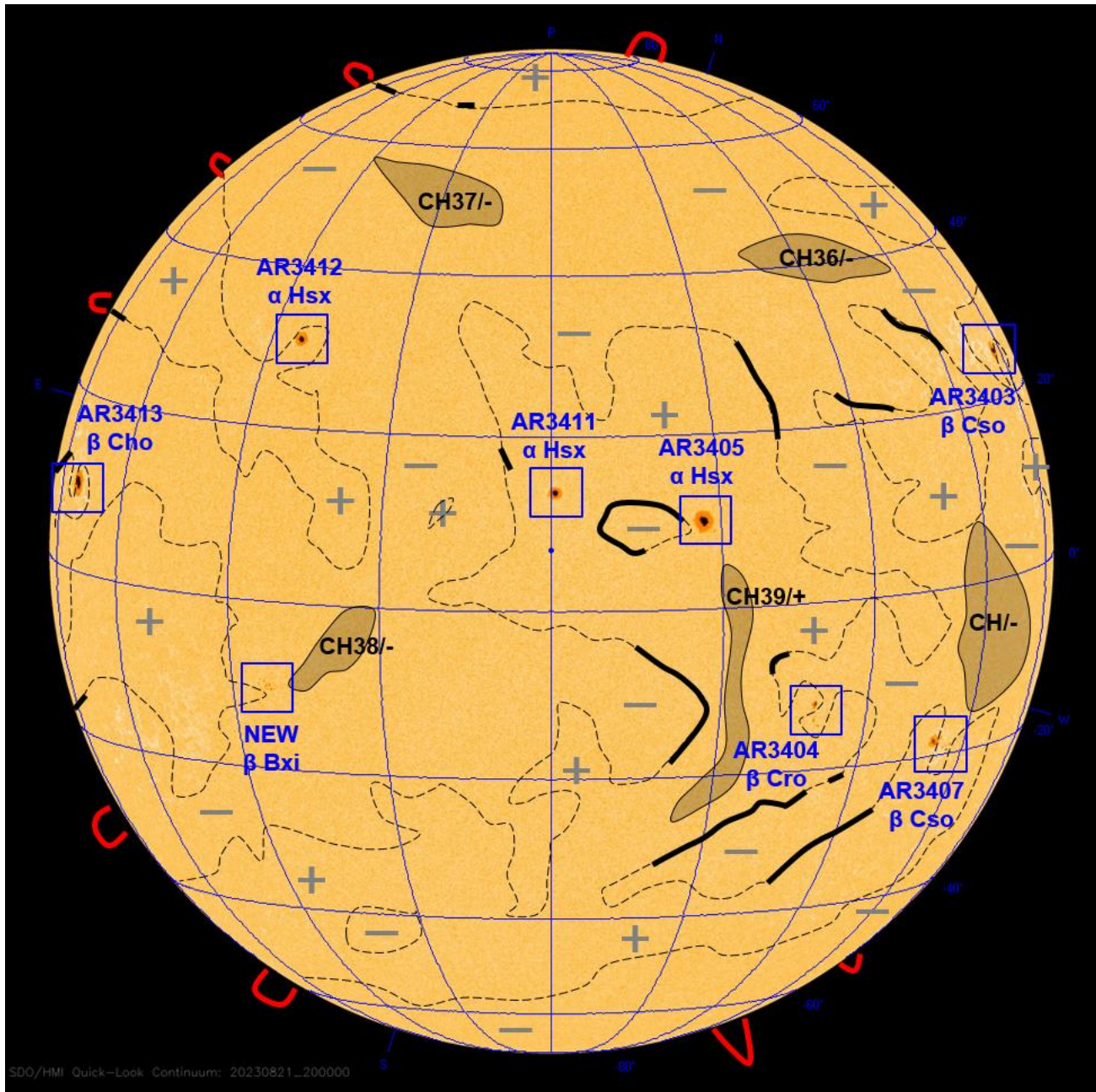
Solar Activity: Solar Activity is expected to be Low, but with a Chance of isolated M-class flares.

Solar Wind / Geomagnetic Activity: Solar winds at L1 are currently Elevated due to the ongoing connection to a trans-equatorial CH in the western hemisphere. The connection to this feature expected to ease further in the next couple of days to Slightly Elevated levels before the arrival of another CH later on Day 2 (23 August). This will likely increase speeds to more persistently Elevated levels once again. This feature then probably eases on Day 3 and 4 (24 and 25 August). No Earth-directed CMEs feature in the forecast.

Geomagnetic activity is therefore forecast to be mostly Quiet to Unsettled (Kp1-3), but on Day 2 there is the Chance for isolated Active periods and a non-zero risk of a G1/Minor Storm interval should there be any protracted period of negative Bz, given the enhanced solar winds predicted.

Energetic Particles / Solar Radiation: High energy (greater than 10 MeV) proton flux is expected to remain at Background levels. High energy electron flux (greater than 2MeV) will probably show an increase in the coming couple of days as the HSS from the current CH likely wanes, with diurnal peaks reaching Moderate, possibly High values. Confidence in the forecast reduces from Day 2 (23 August) onwards with a new CH expected to reduce electron counts for a time, probably continuing into Day 3 (24 August) before increasing uncertainly on Day 4 (25 August). The associated 24-hour fluence will start below Active ($1e8$ integrated pfu), but with a probable upward trend in coming days giving a Chance of reaching the Active threshold on Day 2 (23 August) and a Slight Chance on Days 3 and 4 (24 and 25 August).

Figure 1. Solar Analysis Valid 21/2000 UTC.



Key: Filament ____, Prominence ____, Magnetic Field Line - - -, Polarity +/-, Coronal Holes: Grey shaded area CHxx +/-, Sunspot groups 25xx - Mt Wilson α-β-γ-δ and Zurich-McIntosh Axx etc.

Geomagnetic Storms:

No Earth-directed CMEs currently feature in the forecast period. However, a large number of filaments occupy the Earth-facing disc of the sun and will be closely monitored for any destabilisation and potential lift-offs in the coming days.

Solar winds observed at L1 are currently Elevated with speeds around 520 km/s as the high speed stream HSS from the unnumbered, negative polarity, trans-equatorial coronal hole around 60W continues to slowly ease. An exit from this HSS is expected in the next couple of days with speeds expected to return to Slightly Elevated levels on Day 1 (22 August). It should be noted that Enlil does not feature this HSS in its modelling and as such is unreliable in its forecast detail during the current period.

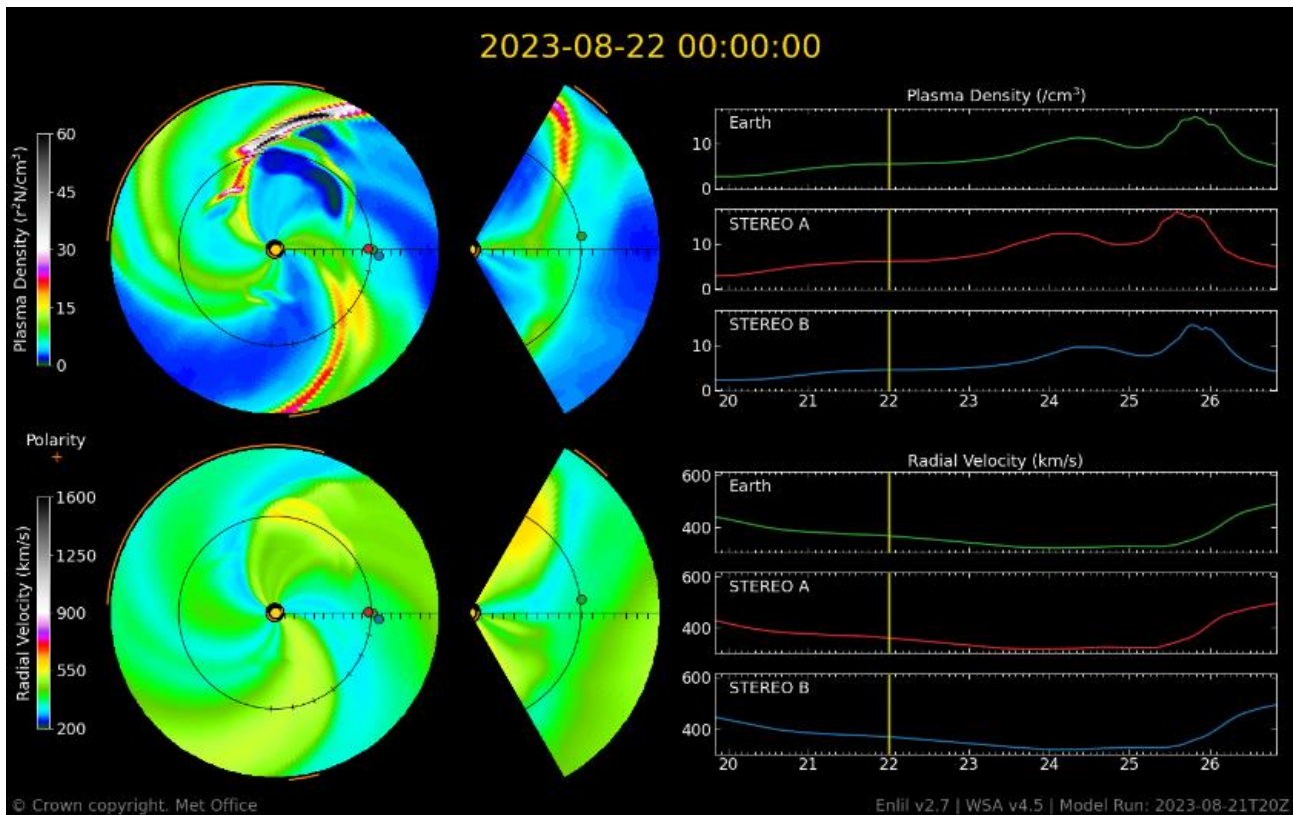
Following this the next recurrent HSS is a positive polarity coronal hole (CH39/+) currently located around 15-20W, extending across the solar equator, but mainly in the southern hemisphere. This region is of large latitudinal extent, but very narrow longitudinal width. As such, confidence in the onset and duration of any connection to this feature is rather low but speeds of 500-580km/s (Elevated) were observed on the previous rotation. With the region appearing broadly similar there is moderate confidence in equivalent effects this time around. The most likely arrival time of this feature is later on Day 2 (23 August), but its influence at L1 should start to weaken again on Day 3 (24 August), continuing into Day 4 (25 August) with speeds estimated to return to Slight Elevated. Enlil is also largely failing to capture this HSS in its forecast for the period, with speeds in the model well below expected values.

Geomagnetic activity is therefore forecast to be mostly Quiet to Unsettled (Kp1-3), but on Day 2 there is the Chance for isolated Active periods and a non-zero risk of a G1/Minor Storm interval should there be any protracted period of negative Bz, given the enhanced solar winds predicted.

Geo-Magnetic Storm	Level	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC)	Day 2 (00-24 UTC)	Day 3 (00-24 UTC)	Day 4 (00-24 UTC)
Probability (Exceedance)			(%)	(%)	(%)	(%)
Minor or Moderate	G1 to G2	No	1	5	1	1
Strong	G3	No	1	1	1	1
Severe	G4	No	1	1	1	1
Extreme	G5	No	1	1	1	1

Geomagnetic Activity - Earthbound Coronal Mass Ejections - Nil

Figure 2: Latest Enlil output from MOSWOC. Notice that observed winds are around 150km/s faster than modelled. An indication that the current HSS is not being accounted for, nor a strong signal for the recurrent feature (CH39/+) on Day 2 (23 August).



Radio Blackouts - X-Ray Flares:

Solar activity is currently Low, with occasional mid-level C-class flares, peaking at C5.7 at 21/2359 UTC from a region currently at the eastern horizon in the southern hemisphere. The 10.7cm Pentiction flux value is relatively low at 149sfu (from a midweek high of 160) but is expected to rise with enhanced flux imminently arriving over the eastern solar horizon. This is likely to dictate a forecast uptick in activity into the new UTC week, despite the loss of AR3403 and AR3407 over the western limb in the coming days.

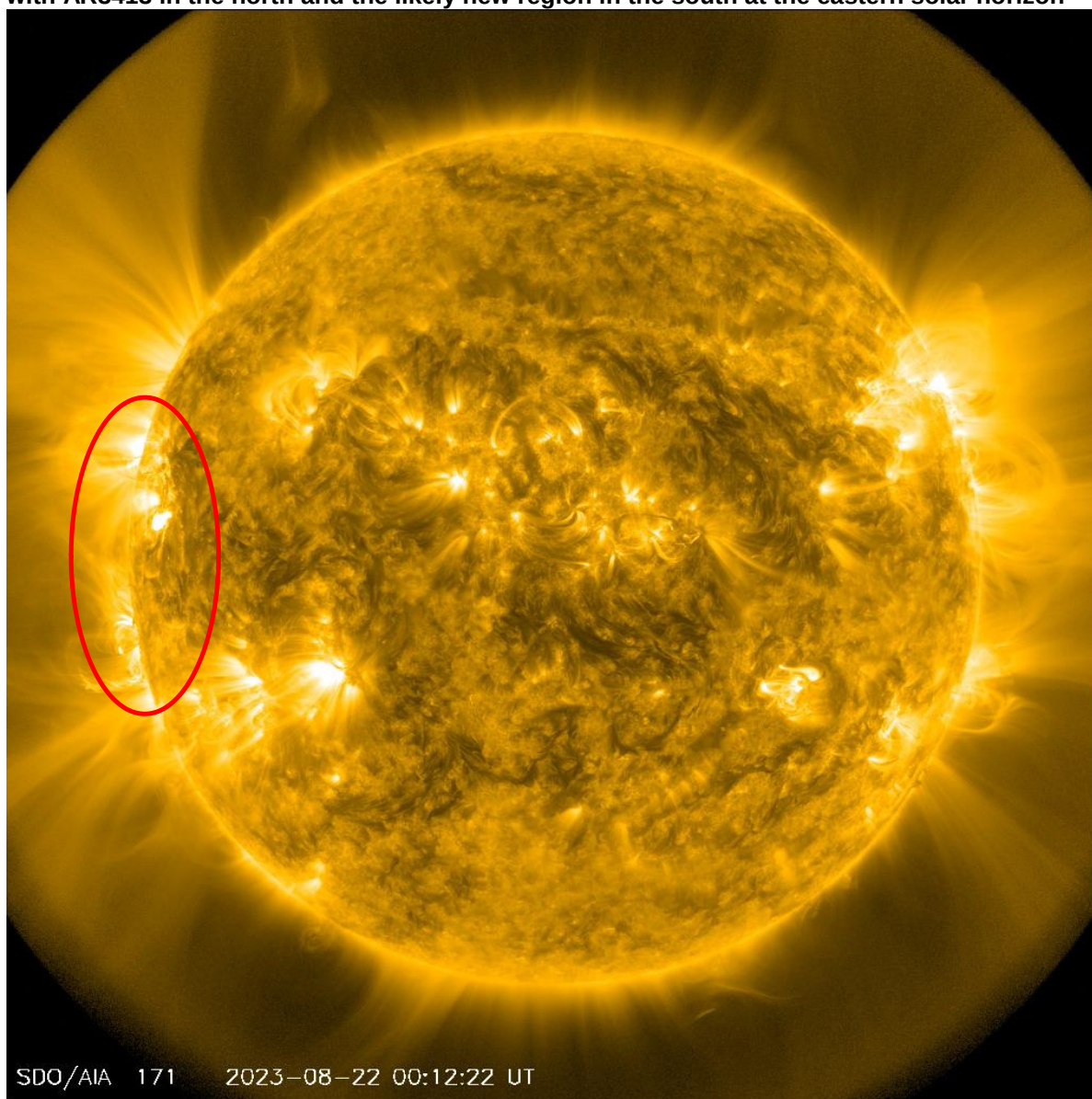
Eight sunspot regions currently feature on the visible disc, with one small un-numbered region in the southeast. AR3413 (Cho/Beta) near the northeast limb has revealed further small spots in addition to the large, leading H-spot. There continues to be occasional low-level C-class flaring from this region. This is the returning Ex-AR3386 that was responsible for an X1.6 flare on 05 August, though at this stage the region appears to have simplified and decayed from a fortnight ago when it was last visible. AR3407 (Cso/Beta) in the southwest, has seen gradual decaying of the lead spots, meanwhile AR3404 (Cro/Beta) has re-emerged, then looked to begin to fade once more. There is little change to the other pre-existing regions which remain generally simple and stable.

The region currently at the eastern horizon presents some bright flux on EUV imagery around 20S and is expected to contain another sunspot group. Despite being far-sided it has been responsible for numerous flares from low to mid-C class level in the past 48 hours and could be a notable region. This appears to be a non-recurrent feature.

Solar Activity is expected to be Low, but with a Chance of isolated M-class flares. The bulk of the potential for significant flares is either from AR3413 or the region soon to rotate over the eastern horizon, given its prior enhanced flare activity in recent days.

X Ray Flares	Level	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC)	Day 2 (00-24 UTC)	Day 3 (00-24 UTC)	Day 4 (00-24 UTC)
Probability			(%)	(%)	(%)	(%)
Active	R1-R2 M Class	No	25	25	25	25
Very Active	R3 to R5 X Class	No	1	1	1	1

Figure 3: SDO/AIA 171 imagery at 22/0012 UTC. Circled are areas of magnetic looping associated with AR3413 in the north and the likely new region in the south at the eastern solar horizon



Solar Radiation Storms - (High Energy Protons):

High energy (greater than 10MeV) proton flux observed by GOES16 is expected to remain at Background levels. There persists an ongoing Slight Chance of proton flux increases from any significant flares, perhaps most likely from the western solar hemisphere, however these are considered very unlikely to reach S1 Minor Solar Radiation Storm levels.

Radiation Storms	Level (cm ⁻² sr ⁻¹ s ⁻¹)	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC)	Day 2 (00-24 UTC)	Day 3 (00-24 UTC)	Day 4 (00-24 UTC)
Probability (Exceedance)			(%)	(%)	(%)	(%)
Active	≥ S1	No	5	5	5	5
Very Active	≥ S3 *	No	1	1	1	1

* S3 ≥ 10 MeV ≥ 1000 pfu and / or ≥ 50 MeV ≥ 10 pfu. (pfu = cm⁻²sr⁻¹s⁻¹)

High Energy Electrons Event (≥ 2MeV):

The high energy (greater than 2 MeV) electron flux is currently at Normal Background to Moderate levels, varying on a typical diurnal trend. A stronger recovery in electron flux at GEO is likely on Days 1 and 2 (22 and 23 August) to occasionally High levels as the current lack of significant geomagnetic activity coincides with a relaxation of the Van Allen Belts. Confidence in the forecast reduces later on Day 2 (23 August) with the forecast onset of a positive polarity CH39 that should reduce electron counts at GEO, continuing into Day 3 (24 August) should geomagnetic activity increase as anticipated. By Day 4 a tentative increase in electron flux is likely again.

MOSWOC REFM modelling does not account for current HSS enhancement in the forecast, and is currently not preferred. The associated 24-hour fluence will start below Active (1e8 integrated pfu), but with a probable upward trend in coming days giving a Chance of reaching the Active threshold on Day 2 (23 August) and a Slight Chance on Days 3 and 4 (24 and 25 August).

GEO Electron Environment	Level (cm ⁻² sr ⁻¹ day ⁻¹)	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC)	Day 2 (00-24 UTC)	Day 3 (00-24 UTC)	Day 4 (00-24 UTC)
Probability (Exceedance)			(%)	(%)	(%)	(%)
Active	≥ 2 MeV ≥ 1x10 ⁸	No	1	30	10	20
Very Active	≥ 2 MeV ≥ 1x10 ⁹	No	1	1	1	1



Figure 4: Latest GOES >2eV Electron Flux observations MOSWOC REFM output

